Swiss Re Institute

Move! Physical activity and its effects on morbidity and mortality risk

Insufficient physical activity is one of the leading risk factors for death and non-communicable diseases (NCDs), including cardiovascular diseases, cancer and diabetes.

This report highlights the global occurrence of physical inactivity; the contribution of insufficient activity to NCDs; and the health benefits of being active. It concludes by illustrating the effects of inactivity on insurers and considers how insurers can encourage policyholders to move more.

> Lack of activity destroys the good condition of every human being while movement and methodical physical exercise save it and preserve it.
>
> Plato, Athenian Philosopher

In spite of humanity having been aware of the importance of physical activity for more than 2 000 years, a quarter of the world's adult population are insufficiently active. If current trends continue, the WHO member states' goal of reducing physical inactivity by ten percent will not be achieved by 2025.[1]

Definition of physical activity

Caspersen et al. define physical activity as "any bodily movement produced by skeletal muscles that requires energy expenditure".[2] In other words, it not only includes sports or planned exercise, but also active mobility, recreational and occupational physical activity.[3]

Physical activity can be measured with a unit called metabolic equivalent of task (MET), which describes the energy expenditure of a specific activity. A MET is the ratio of the rate of energy expended during an activity to the rate of energy expended at rest.[4]

Physical activity[5]

MET
Metabolic **E**quivalent of **T**ask

light-intensity	moderate-intensity	vigorous-intensity
< 3 METs	3–6 METs	> 6 METs

Activity recommendations

The WHO global recommendation on physical activity for health states:

Adults aged 18 to 64 years should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week; or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week; or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity.[3]

In MET terms, this recommendation corresponds to a minimum of about 500 MET-minutes per week.

150 minutes per week of moderate-intensity aerobic physical activity

Examples: walking briskly, playing doubles tennis.

or

75 minutes per week of vigorous-intensity aerobic physical activity

Examples: jogging, running, strenuous fitness class

Global age-standardised prevalance of physical inactivity

2016

27.5% 1.4 billion adults

Guthold et al. pooled data from 358 population-based surveys, including 1.9 million individuals across 168 countries for the years 2001 to 2016. The global age-standardised prevalence of physical inactivity – those not meeting the WHO recommendations on physical activity – amounted to 27.5% in 2016 (1.4 billion adults). The prevalence in men was 23.4% and in women 31.7%.

The highest levels of physical inactivity were found in Latin America and the Caribbean, South Asia and high-income Western countries. The lowest levels were detected in Oceania, East and Southeast Asia and Sub-Saharan Africa.[1]

Physical inactivity in **high-income countries**[1]

2001 **31.6%**

2016 **36.8%**

In 2001, the global prevalence of physical inactivity was 28.5%, suggesting the reduction in physical activity from 2001 to 2016 was not significant. However, in high-income countries the prevalence of physical inactivity increased from 31.6% in 2001 to 36.8% in 2016. The prevalence in high-income countries was more than twofold higher than in low-income countries in 2016 (16.2%).[1]

Increase in physical inactivity in high-income countries
Economic growth affects physical activity negatively as it influences modes of transportation, the use of technology, cultural values and sedentary employment. Urbanisation hinders physical activity because of fear of crime, high-density traffic, low air quality/pollution, and lack of parks, sidewalks and sports/recreation facilities.[6]

Figure 1:
Country prevalence of insufficient physical activity in women in 2016

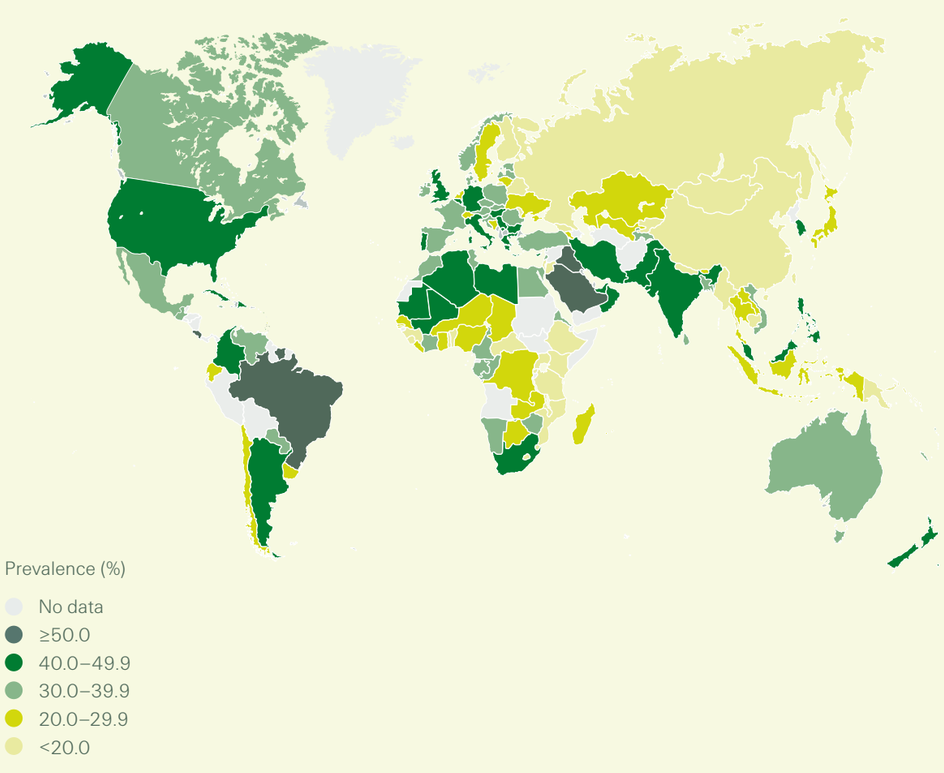
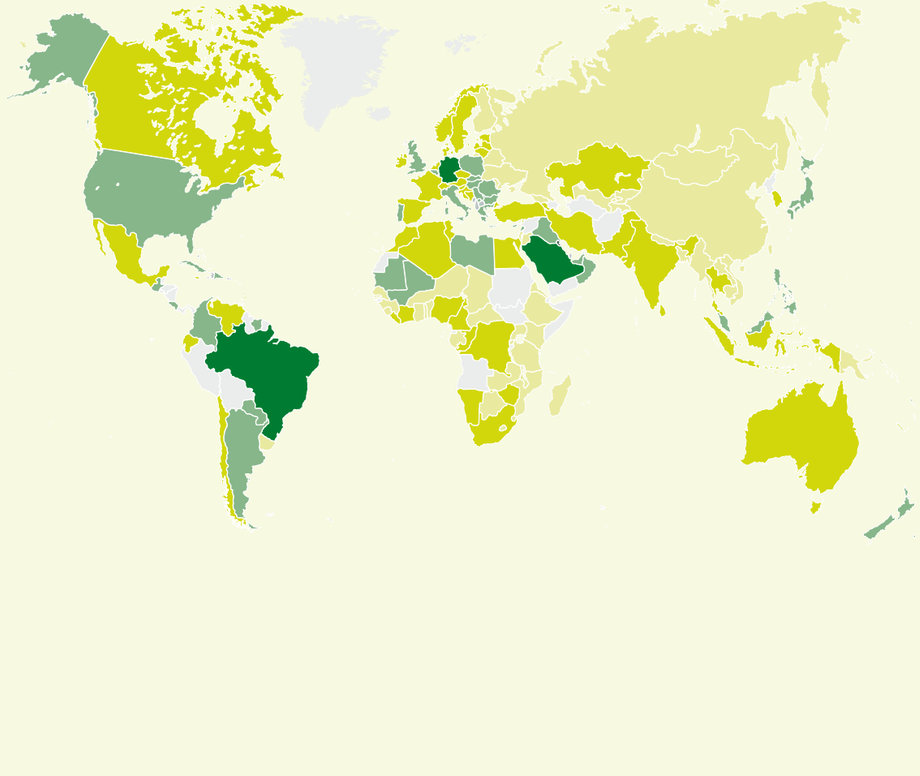


Figure 2:
Country prevalence of insufficient physical activity in men in 2016



Physical inactivity is a leading risk factor for disease and economic burden, shorter life expectancy and death worldwide, especially for NCDs. If the world's population followed WHO physical activity guidelines, the global gain in life expectancy could be as much as 0.68 years.[7] If smoking related deaths were eliminated, adult life excpectancy could increase on average by 2.4 years in men and 1 year in women.[8]

Quantification of the impact of physical inactivity on disease burden

Population attributable fractions (PAF) is a key means of estimating the impact of a risk factor on disease incidence. PAF expresses the proportion of new cases of disease that would not occur if a certain risk factor did not exist.

Higher physical activity levels are associated with graded reduction in mortality and major cardiovascular diseases.[9] Figure 4 represents the relative risk values for different physical activity levels for incidence of breast cancer, colon cancer, diabetes, ischemic heart disease and ischemic stroke respectively. For instance, for those with physical activity levels of 600–3 999 MET-minutes per week (light intensity) there was a 16% associated lower risk of ischemic heart disease, compared to people who were insufficient physically active. For the activity categories '4 000–7 999 MET-minutes per week' (moderate intensity) and '≥ 8 000 MET-minutes per week' (vigorous intensity), the associated risk of ischemic heart disease was, in comparison to inactive people, reduced by 23% and 25%, respectively.[10]

Figure 3:
The global burden of the following diseases could be significantly reduced, if all inactive people (not meeting the WHO recommendations on physical activity) became active[7]. This unhealthy behaviour is responsible for 9% of premature death that occurred worldwide in 2008.

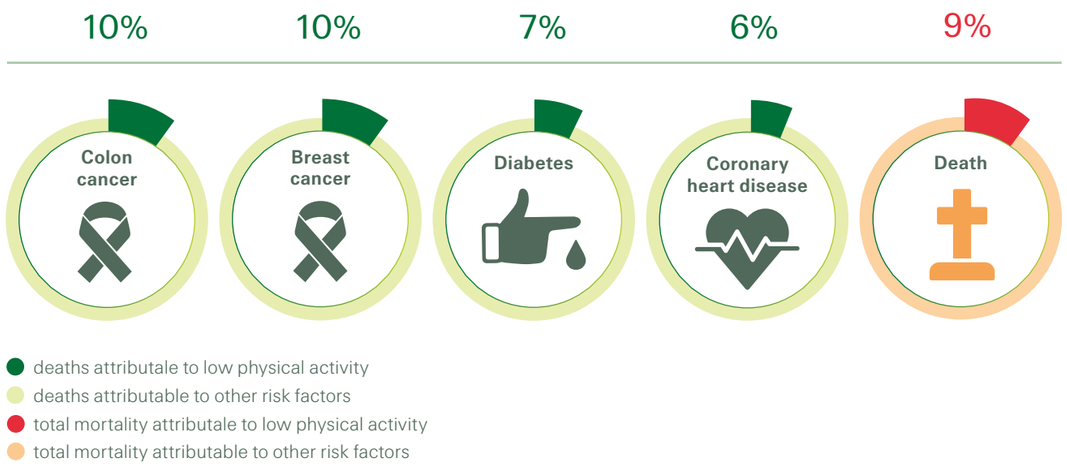
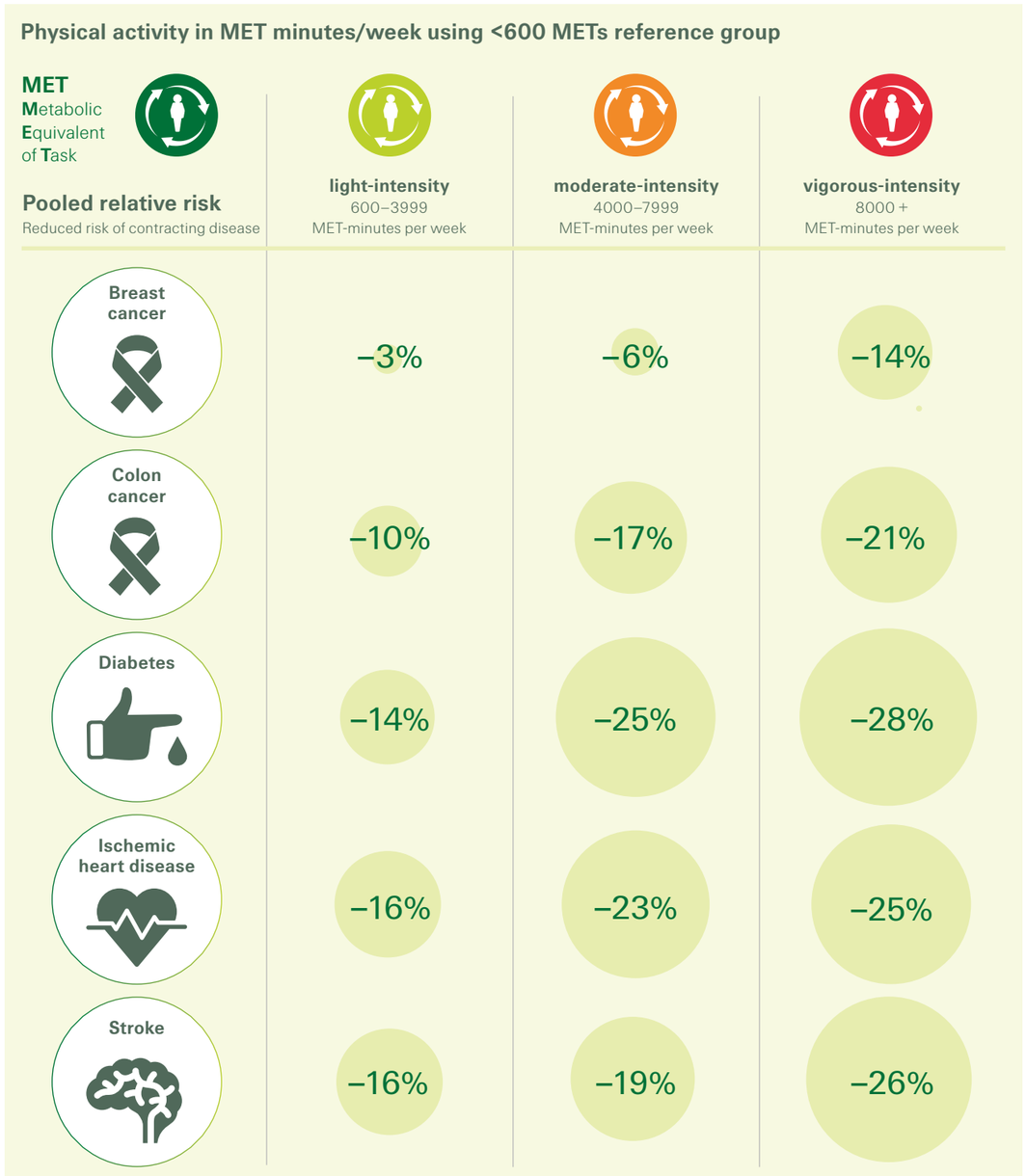


Figure 4:
Relative risks comparing insufficient physical activity with different activity levels for the incidence of breast cancer, colon cancer, diabetes, ischemic heart disease and ischemic stroke.[10]

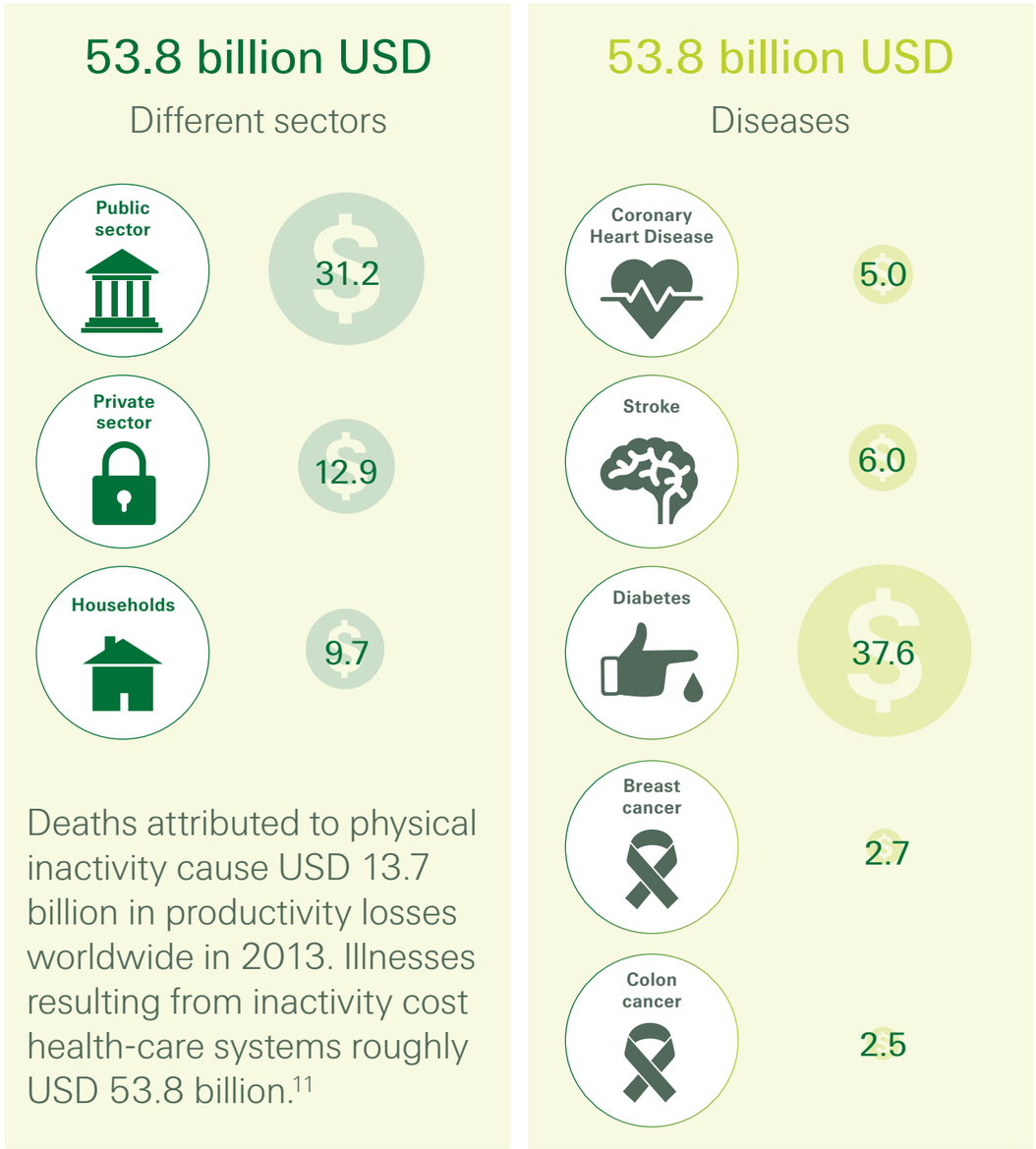


Relative risk is a measure that states the relative likelihood of the event occurring in an exposed group versus a non-exposed group. It does not explain the absolute risk of the event occurring.

Contribution of physical inactivity to economic burden

In addition to morbidity and mortality, physical inactivity raises economic burden. Whereas low- and middle-income countries were affected to a greater degree by the disease burden (75% of Disability Adjusted Life Years (DALYs), high-income countries are proportionally more affected by economic burden (81% of health-care costs and 60% of indirect costs).[11] Figure 5 illustrates how the health-care costs are divided for different sectors and per disease.

Figure 5:
Division of health-care costs: left, for different sectors; right, per disease[12]



Deaths attributed to physical inactivity cause USD 13.7 billion in productivity losses worldwide in 2013. Illnesses resulting from inactivity cost health-care systems roughly USD 53.8 billion.[11]

Low physical activity

Contribution of low physical activity to mortality and disease burden

The Global Burden of Disease (GBD), a project of the Institute of Health Metrics and Evaluation (IHME), defines low physical activity as a continuous risk factor variable. Compared to other literature, which simply differentiate between being inactive or active, GBD estimates the optimal level of physical activity for overall health. The GBD labels low physical activity as 3 000–4 500 MET-minutes per week.[12] The impact of insufficient physical activity includes a much wider range of activity levels than the WHO recommendations on physical activity.

Thus, 2.27% of all-cause deaths and 0.91% of all-cause DALYs were attributable to low physical activity. By comparison, the risk factor smoking caused 7.10 million deaths and 182.48 million DALYs worldwide in 2017 (12.22% of total all-cause deaths; 6.86% of total all-cause DALYs).[12]

Quantification of the impact of low physical activity on different diseases

GBD determined the diseases leading to mortality that are impacted by low physical activity through an extensive search and meta-analysis of the best available evidence concerning risk and outcomes. Ischemic heart disease is the condition most affected by low physical activity, followed by stroke (see Figure 6).

Ischemic heart disease as a cause of death or disability is the most affected by low physical activity, with stroke being the second disease most affected.

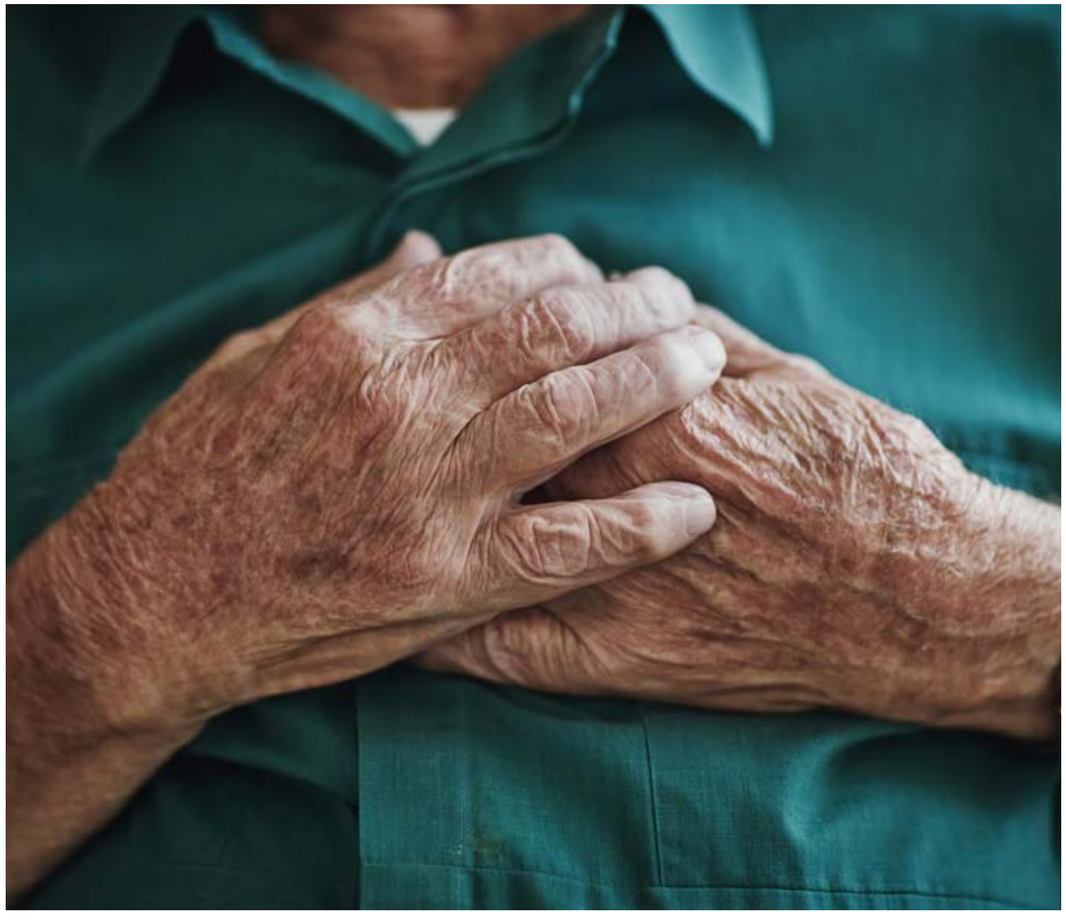
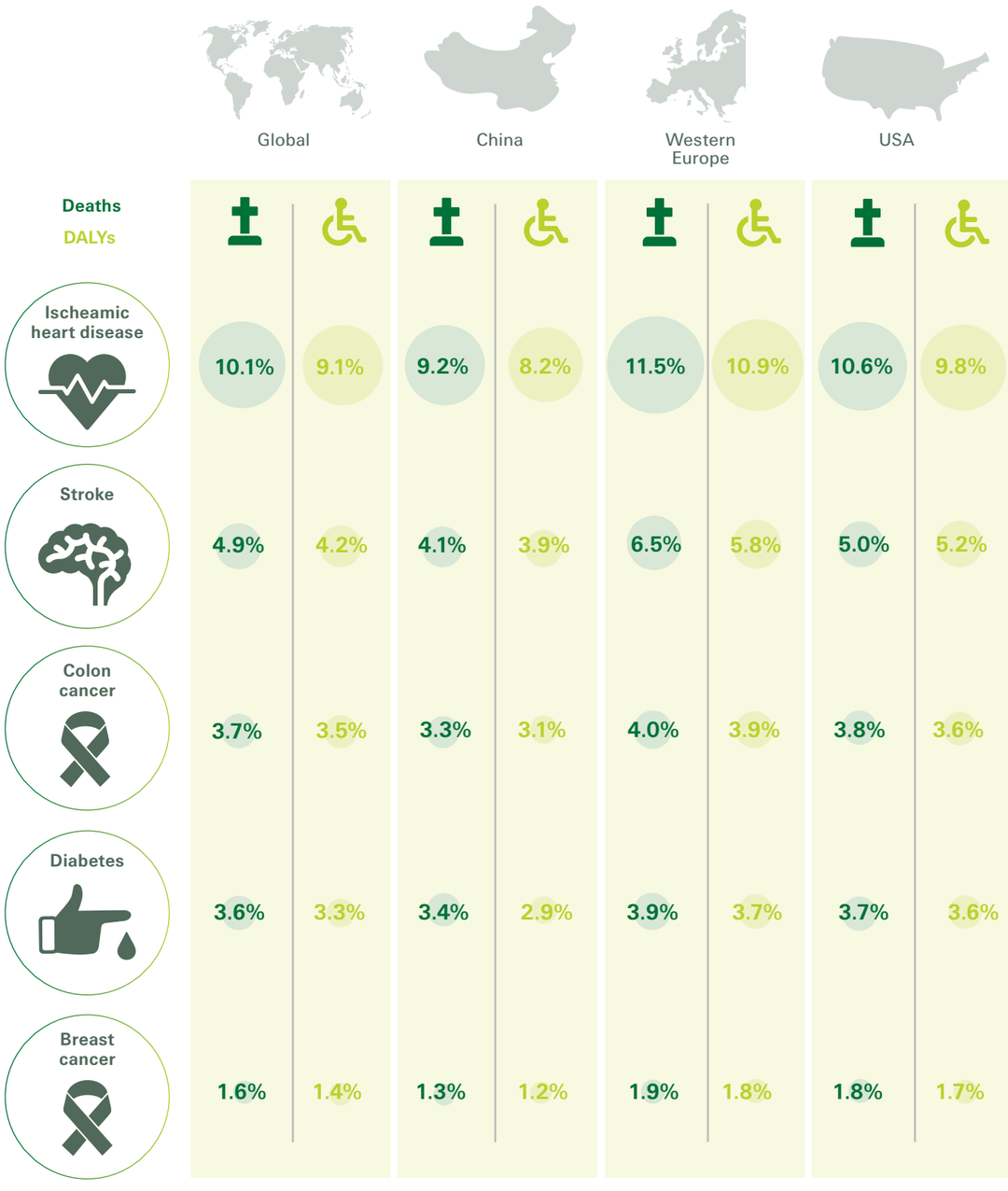


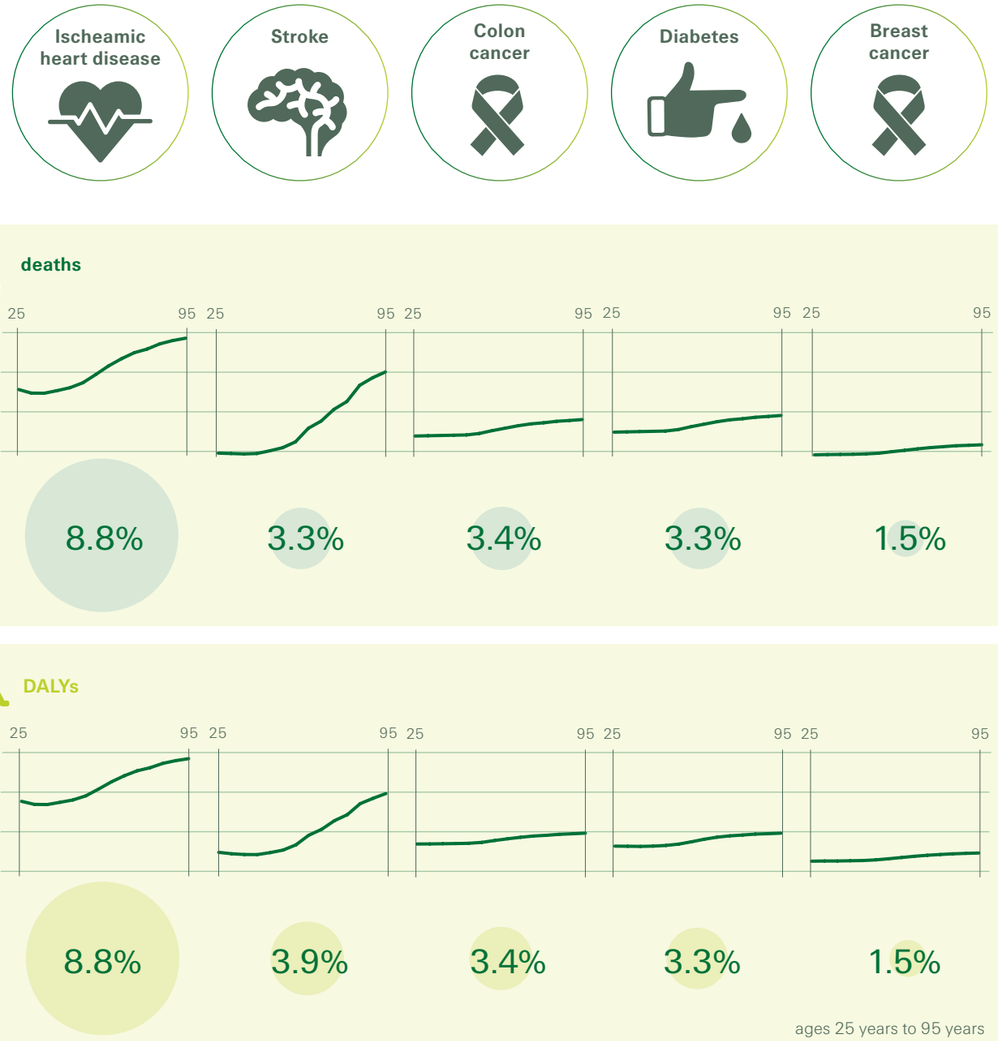
Figure 6:
Regional overview of deaths/DALYS attributable to low physical activity in 2017, for both sexes, age-standardised, for causes of death/DALYs: ischemic heart disease, stroke, colon and rectum cancer, type 2 diabetes mellitus and breast cancer[11].



Impact of low physical activity on different age groups

The proportion of deaths/DALYs attributable to low physical activity increases with age for ischemic heart disease, stroke, colon and rectum cancer, type 2 diabetes mellitus and breast cancer. The contribution increases more steeply at 40 and 55 years respectively for ischaemic heart disease and stroke (see Figure 7).[12]

Figure 7:
Global overview of deaths/DALYs attributable to low physical activity in 2017, for both sexes, ages 25 to 95, for causes of death: ischemic heart disease, stroke, colon and rectum cancer, type 2 diabetes mellitus and breast cancer[12].



The publications of Mok et al., Mandsager et al. and Gubelmann et al. presented findings that increasing physical activity levels have a high potential to improve health. Mok et al. found that middle aged and older adults, including those with cardiovascular disease and cancer, can gain substantial longevity benefits if they increase their physical activity levels. This is irrespective of past physical activity levels and established risk factors (including overall diet quality, bodyweight, blood pressure, triglycerides and cholesterol). Long term increases in physical activity energy expenditure were inversely associated with all-cause-, cardiovascular disease- and cancer mortality. For a trajectory of being inactive at baseline and gradually, over five years, meeting the WHO recommendations (150 minutes of moderate-intensity physical activity per week), the associated risk of all-cause mortality reduced by 24%, the associated risk of cardiovascular disease mortality by 29% and the associated risk of cancer mortality by 11% respectively.[13]

Another study, one of Mandsager et al., highlighted that cardiorespiratory fitness was inversely associated with all-cause mortality without an observed upper limit of benefit. Cardiorespiratory fitness was measured among adults undergoing exercise treadmill testing and was quantified by peak estimated METs. The elite group, which demonstrated extremely high aerobic fitness (≥ 2 standard deviations above the mean for age and sex) was associated with the lowest risk-adjusted all-cause mortality compared with the other performance groups (low, below average, above average, high). Extreme aerobic fitness level was especially of benefit in older people and those with hypertension. The study illustrates the importance of aerobic fitness as a powerful, modifiable indicator of long-term mortality. Adjusted mortality risk of reduced cardiorespiratory fitness was greater than or equal to traditional clinical risk factors, such as coronary artery disease, diabetes or smoking.[14]

Considering the association of activity behaviours and patterns with cardiovascular risk factors, the CoLaus study presented that high physical activity levels were associated with a favourable cardiovascular risk profile. Individuals (aged 45 to 86 years), who were high physically active (more than 133 minutes per day of average moderate- and vigorous-intensity aerobic physical activity), were less likely to smoke, and less prone to be obese or hypertensive, independently of the activity distribution over the week.[15]

In high-income countries, the top twelve causes of death accounted for 63% of total deaths in 2017. Ischemic heart disease was the leading cause, followed by stroke at third, colon and rectum cancer at seventh, diabetes at ninth and breast cancer at twelfth.[12]

As physical inactivity contributes to the mentioned leading causes of death, one would reasonably expect it to contribute materially to mortality claims. We expect, if prevalence of inactivity in high-income countries continues to grow, this will be reflected in future cardiovascular mortality claims. As breast and colon and rectum cancer are important causes of death in the insured population, we assume also a future raise in claims triggered by those types of cancers.

The main causes of claims in critical illness (CI) insurance are lung, breast and other cancers. Here, the picture varies from region to region. With physical inactivity increasing in prevalence in high-income countries and contributing to breast and colon and rectum cancer, a rise in claims frequency may be observed going forward. Medical, long term care (LTC) and disability claims costs would also be affected. As the contribution of insufficient physical activity to mortality and disease burden increases with age, an impact on whole life policies would especially be expected.

> To achieve significant health improvements, physical activity needs to be addressed together with other risk factors.

What can insurers do to increase physical activity?

If insurers can support a behaviour change in the insured population by helping individuals become more physically active, this may, as demonstrated in this paper, lead to a reduction in claims. Initiatives targeting an increase in physical activity have the potential to make the insured population healthier, as well as creating a good tool for engagement. It would further promote a positive image of the insurers to play an active role in improving people's health. To achieve significant health improvements, physical activity needs to be addressed together with other risk factors, such as malnutrition, stress and sleep disorders.

Changing behaviours

Physical inactivity is, to an extent, the result of influences on human behaviour – thus one must understand the drivers of behavioural change. Physical inactivity – alongside other unhealthy behaviours – is frequently challenging to influence and change, especially over the longer term. We can refer to models of behavioural change to help us understand how best to sustainable replace bad behaviours with good ones. For example, the COM-B model of behaviour.[16] The Behaviour Change Wheel (BCW) has been developed as a robust framework for behaviour change intervention design. Its centre incorporates the COM-B model, termed a "behaviour system", with choices of interventions (e.g. persuasion, education, incentivisation) relevant to those components, and related policies to enact said interventions.[17] Unconscious bias, a focus for the field of behavioural economics is also a relevant element in physical inactivity (focused on System 1 in Kahneman's dual process theory).[17]

COM-B model of behaviour

- Capability (psychological and physical)
- Opportunity (physical and social)
- Motivation (reflective and automatic)

The use of technology, such as wearables and apps, is one way that a number of insurers are attempting to improve physical activity (and general good health) of their policyholders. Tracking physical activity with wearables/ apps can produce short-term improvements to physical activity.[18] Do these effects sustain longer term, which is likely key for health benefits to be realised?

> Research found that 32% of users stopped using their wearable device after six months. At one year this number reached 50%.[19]

Another strategy is incentivising physical activity. Hafner et al. found that particularly loss-framed incentives (with an average 34% increase of tracked activity days per month) can promote higher physical activity compared to gain-framed incentives. The positive association persists over a period of 24 months when the person is continually incentivised to maintain this behaviour change. Although inactive people are less likely to take up such a programme, if they do, it leads on average to higher improvements than are observed in already more active people.[20]

> The jury is still out on whether behaviours can be changed in the long term on a relevant enough scale.

However, most health behaviour change interventions have only short-term effects and there is a high rate of relapse.[21] The jury is still out on whether behaviours can be changed in the long term on a relevant enough scale – research in this area remains a key topic. Technology/ wearables and interaction with policyholders alone are not a solution to creating long-term health behaviour change – incorporating behavioural change theory, such as the BCW, and insights from behavioural economics is a key component when developing solutions that seek to address the challenge of physical inactivity. Zimmerman suggests some ways in which behavioural economics can be applied to physical activity noting the relevance of social norms, framing and habit-formation.[22] Patel, Chang and Volpp add that gamification – using game elements such as collecting points to achieve new levels – can improve health behaviour change. Importantly, incorporating behavioural insights, like opt-out framing of programme participation, personalised achievable goal-setting, signing of a pre-commitment pledge, the concept of loss-aversion, giving regularly fresh starts and anticipating regret, can effectively influence desired actions.[23] The key, as with any intervention, would be to iteratively test any changes made and measure their impact.

Continual monitoring supports ongoing underwriting assessments that allow dynamic pricing and improved customer engagement.

Seeking solutions

There is an increasing interest in the market for the topic of "modifiable risks" including physical activity. Insurers are starting to bundle health services together with claims payments. Continual monitoring establishes not only a basis for providing health services, it also supports ongoing underwriting assessments that allow dynamic pricing and improved customer engagement. This approach could be extended to cover unhealthier customers additional to young healthy lives, which are already largely retailed to yet. Insured parties and insurers synergistically benefit from improved health outcomes.

However, interpreting physical activity data (for example step counts) is not yet conclusive. As a result, underwriting still largely relies on traditional risk snapshot signals, such as body mass index (BMI), rather than on dynamic lifestyle data. This will only change with more research and evidence on the effects of physical activity. Most particularly this will include: the minimum duration of increased physical activity to reliably expect a sustained health improvement; and about how to combine physical activity with other lifestyle adjustments in order to achieve the best outcome. Dynamic solutions need to be attractive to both more active and more sedentary individuals.

Conclusion

The potential benefits of increasing physical activity for all age and population groups, including people with cardiovascular disease or cancer, are huge. Hence, it is never too late to start being more physically active.

References

1. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. The Lancet Global health. 2018;6(10):e1077-e86.

2. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-31.

3. WHO. Global recommendations on physical activity for health. Geneva: World Health Organization. 2010.

4. U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans, 2nd edition. Washington, DC: U.S. Department of Health and Human Services; 2018.

5. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995;273(5):402-7.

6. WHO. World Health Organization. Noncommunicable diseases and their risk factors (Accessed April 2019, at https://www.who.int/ncds/prevention/physical-activity/inactivity-global-health-problem/en/).

7. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012;380(9838):219-29.

8. Rentería E, Jha P, Forman D, Soerjomataram I. The impact of cigarette smoking on life expectancy between 1980 and 2010: a global perspective. Tob Control. 2016; 25(5): 551-7.

9. Lear SA, Hu W, Rangarajan S, Gasevic D, Leong D, Iqbal R, et al. The effect of physical activity on mortality and cardiovascular disease in 130 000 people from 17 high-income, middle-income, and low-income countries: the PURE study. Lancet. 2017;390(10113):2643-54.

10. Kyu HH, Bachman VF, Alexander LT, Mumford JE, Afshin A, Estep K, et al. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. BMJ. 2016;354:i3857.

11. Ding D, Lawson KD, Kolbe-Alexander TL, Finkelstein EA, Katzmarzyk PT, van Mechelen W, et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. Lancet. 2016;388(10051):1311-24.

12. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018. Available from http://ghdx.healthdata.org/gbd-results-tool. (Accessed May 2019).

13. Mok A, Khaw KT, Luben R, Wareham N, Brage S. Physical activity trajectories and mortality: population based cohort study. BMJ. 2019;365:l2323.

14. Mandsager K, Harb S, Cremer P, Phelan D, Nissen SE, Jaber W. Association of Cardiorespiratory Fitness With Long-term Mortality Among Adults Undergoing Exercise Treadmill Testing. JAMA Netw Open. 2018;1(6):e183605.

15. Gubelmann C, Antiochos P, Vollenweider P, Marques-Vidal P. Association of activity behaviours and patterns with cardiovascular risk factors in Swiss middle-aged adults: The CoLaus study. Prev Med Rep. 2018;11:31-6.

16. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci. 2011;6:42.

17. Kahneman, D. (2011). Thinking, fast and slow. New York, NY: Farrar, Straus and Giroux.

18. Gal R, May AM, van Overmeeren EJ, Simons M, Monninkhof EM. The Effect of Physical Activity Interventions Comprising Wearables and Smartphone Applications on Physical Activity: a Systematic Review and Meta-analysis. Sports Med Open. 2018;4(1):42.

19. Ledger, D. 2014. Endeavour Partners Report: Inside wearables: How the science of human behavior change offers the secret to long-term engagemnet. (Accessed July 2014, at http://endeavourpartners.net/assets/Endeavour-Partners-Inside-Wearables-Part).

20. Hafner, Marco, Jack Pollard, and Christian Van Stolk, Incentives and physical activity: An assessment of the association between Vitality's Active Rewards with Apple Watch benefit and sustained physical activity improvements. Santa Monica, CA: RAND Corporation, 2018. https://www.rand.org/pubs/research_reports/RR2870.html.

21. Middleton KR, Anton SD, Perri MG. Long-Term Adherence to Health Behavior Change. Am J Lifestyle Med. 2013;7(6):395-404.

22. Zimmerman FJ. Using behavioral economics to promote physical activity. Prev Med. 2009;49(4):289-91.

23. Mitesh S. Patel, Stacey Chang, Kevin G. Volpp. 2019. Harvard Business Review. Improving Health Care by Gamifying It. (Accessed June 2019, at https://hbr.org/2019/05/improving-health-care-by-gamifying-it).

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